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IS THE DAKOTA FORMATION UPPER OR LOWER CRETACEOUS?

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BECAUSE of the quite diverse classification of this formation by prominent geologists, the writer has desired to find for himself a satisfactory answer to the above question. Thinking that it may be of interest to others also, he offers this paper.

The formation was first limited and named by Meek and Hayden in 1856. The name was derived from Dakota City, opposite Sioux City, Iowa, and was applied to a thick stratum of rusty sandstone there exposed for 50 or 60 feet, and in other localities found to attain 400 or 500 feet. They recognized its Cretaceous character, but as that system was not very well known, and because the Dakota rests upon the Carboniferous there, it was judged by them to be at or near the base of the Cretaceous.

In 1859 Beer and Lesquereaux decided that the leaves found abundantly in the formation indicated Tertiary age, but Meek and Hayden showed by the invertebrate life that it was at least Cretaceous.

In 1870 Credner pointed out similarities between the New Jersey Cretaceous and the Senonian, or Upper Cretaceous, of Europe, forty species being common to both.

Dr. C. A. White, in his "Correlation" paper on the Cretaceous (1891), concludes that "the Dakota is as clearly distinguishable as a separate formation in the northern and central portions of the south interior region as it is at the typical localities in the northern interior region, in all of which districts the strata are plainly of non-marine origin. In the southern part of the southern interior region, however, as well as in central Kansas and in eastern Texas, the strata which are confidently regarded as representing the Dakota formation are found to bear true marine fossils, and in some cases both paleontologically and stratigraphically to blend so intimately with the next overlying strata, which are regarded as equivalent to the lower part of the Colorado formation, as to render their interdelimitation indistinct."¹

Prof. Lester F. Ward, in 1894, found cycads of the Lower Cretaceous in the lower part of the Dakota in the southern Black Hills,

1. U. S. G. S. Bull., 82, p. 158.

though the upper strata contained forms very different from them and closely similar to, though not identical with, well-known forms from the true Dakota elsewhere.²

In 1895 Cragin showed that some of the invertebrates in the Dakota beds at Mentor, southwest of Salina, Kan., were identical with some in the Kiowa shales in the Comanche, in the southern part of that state. These were partly the same as those which Meek had described from that locality and referred to the Dakota in his final report on the invertebrates of the Cretaceous.

In 1896 T. W. Stanton stated that he had no doubt that the Mentor beds are the equivalent of the Comanche, for not only invertebrate fossils but plants harmonize with that view.³

Prosser expressed a similar conclusion, and claimed as additional evidence that Cope had provisionally referred teeth found in the Kansas Dakota to Lepidotid fishes, and stated that he had never found Lepidotid fish remains in the Upper Cretaceous of North America, while they were characteristically Lower Cretaceous and Jurassic in Europe. He also stated that the Mentor invertebrates are from either the same or higher beds as some which have furnished plants characteristic of the Dakota.⁴

In 1901 Darton, in his report on the Black Hills, following the decisions of Ward, proposed to separate the original Dakota of Hayden into three formations—the Lakota, the Fuson and the Dakota, the last being the upper third of the original. This he placed in the Upper Cretaceous, while the others were considered Lower Cretaceous. As he states it, “the sandstone formerly designated ‘the Dakota sandstone,’ or ‘Cretaceous No. 1,’ has in the last few years been found to comprise not only a formation carrying an Upper Cretaceous flora, but an extensive series of Lower Cretaceous deposits as well. Accordingly, the term Dakota has been restricted to the upper sandstone, containing the Upper Cretaceous flora, while the much thicker, lower series has been separated as Lower Cretaceous; and as it consists of several stratigraphic units, these will be differentiated here as separate formations.”⁵

In 1905 Grabau brought out the principle of overlap, transgressive and regressive, and applied it to the Dakota formation, among others. After a lengthy and lucid discussion, he sums up as follows:

“The interpretation of these sections, in the light of the princi-

2. *Journal of Geology*, vol. II, p. 263.

3. Letter to Prosser quoted, *K. U. Geol. Survey*, vol. II, p. 190.

4. *Ibid.* p. 192.

5. *U. S. G. S.*, 21st Ann., part IV, p. 526.

ples discussed, shows us that the Dakota sandstone represents the deposits between the retreat and readvance of the sea. The retreat, as we have seen, began in Washita time, almost at the beginning of that period. The Washita division itself is the depositional equivalent of the retreatal Dakota sandstone, and hence the Dakota is actually of Washita age—of lowest Washita in the northern and of highest Washita in the southern area. The retreat of the sea was considerable, as shown by the unconformity between the Buda and the Eagle Ford and by the thinness of the latter. With the readvance of the sea a new fauna, an immigrant from Europe, came in; and as the sea continued to advance the continental sands of the Dakota-Woodbine-Graneros were reworked and incorporated as basal deposits of later Cretacic age. The Upper Dakota sandstone is thus of Eagle Ford-Benton age, the return of the sea being finally accomplished in mid-Benton time.

“From this it appears that the Dakota sandstone cannot be included as a time element of the standard scale, since it represents different time in different localities. This consideration also suggests that the Washita be made the base of the Middle Cretacic, the classification being approximately the following:

		Marine.	Nonmarine.
Upper Cretacic-Montanian	{	Navarro.....	{ Laramie.
		Taylor	
		Austin.	
Mid-Cretacic	{	Eagle Ford.	
		Unrepresented interval.....	{ Dakota.
		Washitan	
Lower Cretacic-Comanchean.....	{	Fredericksburg.	
		Trinity.	

“If two systems are to be made of the present Cretacic, the Comanchic system would end with the Washitan, and the Cretacic begin with the Coloradoan, the unknown base of which must be looked for in southern Texas or in Mexico.⁶”

Dr. W. B. Scott, in his “Introduction to Geology” (2d edition, 1907), in his tabular presentation of Cretaceous formations, follows Grabau, and represents the Dakota as belonging to the Lower Cretaceous. In the discussion in the text he says:

“Whenever the marine Upper Cretaceous is in contact with the Comanche limestones north of Mexico, the two are unconformable, and no species of animal is known to pass from one to the other. In Mexico the Lower Cretaceous passes into the Upper without a break, the disturbances there taking place at a later date.

“The Upper Cretaceous rocks have a far wider distribution over North America than have those of the lower division, which is due

6. Bull. Geol. Soc. Am. (1905), vol. 17, p. 627.

to an enormous transgression of the sea over the land, one of the greatest in all recorded geological history. Over the region of the Great Plains the Upper Cretaceous was inaugurated by the formation of a nonmarine stage, the Dakota."⁷

This seems at first discordant with the table, but, in the light of it, he may mean that the terrestrial Dakota—formed over the Great Plains contemporaneously with the upper portion of the marine Comanche further south—seems in that region to begin the Upper Cretaceous, but in no other way could a nonmarine formation be said to inaugurate a marine formation. Hence, logically, the division between the Lower and Upper Cretaceous should be above the Dakota rather than below it.

In view of these facts, it is with surprise that we find that Chamberlin and Salisbury's "College Geology," recently published, distinctly places the division between the Lower and Upper Cretaceous below the Dakota, and, moreover, makes it a break between periods instead of epochs as heretofore, though the authors are constrained to add that "north of Texas the formation (Dakota) is in apparent conformity with the Comanche in some places; though in others, as in the Wasatch and Uinta mountains, it rests on older formations."⁸ They are, as a result, betrayed into figuring a cycad from the Dakota as illustrating Comanche life.

The results of our research may be briefly summed up as follows:

All the students of the Dakota formation seem now to be agreed that it is mainly Lower Cretaceous in age, and most recent writers on the subject express themselves to that effect, while some have referred the whole of it to that epoch.

That the latter position is right seems clear for the following reasons:

1. From the standpoint of stratigraphy, it is questionable whether much, if any, of the present Dakota sandstone was laid down contemporaneously with any of the marine Upper Cretaceous. No doubt there were terrestrial deposits laid down over the Great Plains, while marine beds, now recognized as Upper Cretaceous, were forming in southern Texas or Mexico; but in the later transgression of the sea northward several feet in thickness of such beds must have been cut away by the wave action and rearranged in the Benton of the Upper Cretaceous, as Grabau argues. This may have removed all which was formed on the land during such transgression, and should it ever be found to be otherwise, still the

7. *Int. to Geol.*, pp. 702, 705.

8. *Coll. Geol.*, p. 747.

rational and most convenient place of division would be above the Dakota.

2. The invertebrate remains of the Dakota are closely akin to those counted Lower Cretaceous, and are quite distinct from those of the Upper Cretaceous. The plant life, also, though less decisive, is in part at least coördinate with that of the beds below rather than with that of those above. The paleontological evidence, therefore, favors the same division as the stratigraphical.

3. Lithologically, also, the most natural classification will be to put the whole of the Dakota, as originally limited, in the Lower Cretaceous. To divide it in most cases brings greater confusion. The division between the Dakota and Benton is not very sharply defined, for it takes a few scores of feet to change from a decidedly sandy formation to one decidedly clayey, several variable thin strata of sand and shale being intermingled between. As it marks the advent of the sea, however, the occurrence of marine fossils assists in the demarkation.

Though such a division cannot be looked upon as marking a point of time, but as progressively constructed from north to south over the Great Plains, yet it is better marked and probably records a shorter time than most similar divisions in geologic history.